

NASA Advisory Council Space Operations Committee

April 17, 2008

C. Paul Robinson (chair)

Eileen Collins

Pat Condon

Thomas Jones

David Longnecker

Benjamin Montoya

Agenda

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- **Follow-up on February Meeting Activities**
- **U.S. Commercial Expendable Launch Vehicle Forecast**
 - with the NAC Science Committee
- **Commercial Orbital Transportation System (COTS)**
- **Iran/North Korea/Syria Non-Proliferation Act (INKSNA)**
- **Pressurized Lunar Rover and Lunar EVA Capabilities**
 - with the NAC Exploration Committee
- **Forward Activity**

Follow-up on February Meeting Activities

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- Capturing and transferring operations and accident lessons learned to new employees and developers (CONTINUING TO MONITOR)
- Request additional briefings on pressurized rover power requirements and EVA/suit sealing systems (BRIEFED IN APRIL, WILL CONTINUE TO MONITOR)
- Potential site visit to the Michoud Assembly Facility during April visit (NO OPPORTUNITY IN APRIL)
- Continue to monitor transition of workforce and vendor capabilities from Space Shuttle to Constellation (in conjunction with Human Capital and Exploration Committees) (HUMAN CAPITAL COMMITTEE BRIEFED IN APRIL)

Follow-up on February Meeting Activities

(continued)

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- Continue to monitor progress of Commercial Orbital Transportation System (BRIEFED IN APRIL, WILL CONTINUE TO MONITOR)
- Continue to monitor utilization of ISS as a National Laboratory (with Exploration Committee and Biomedical Subcommittee) (ONGOING ACTION, WILL CONTINUE TO MONITOR)
- Continue to monitor the long-term availability of medium launch capabilities (with Science Committee) (BRIEFED IN APRIL, WILL CONTINUE TO MONITOR)
- Continue to monitor the development of the lunar outpost architecture for indefinite operational life (with Exploration Committee) (CONTINUING ACTION, WILL CONTINUE TO MONITOR)
 - radiation exposure limits for long-duration surface stays
 - comparison with maintaining ISS

U.S. Commercial Expendable Launch Vehicle Forecast

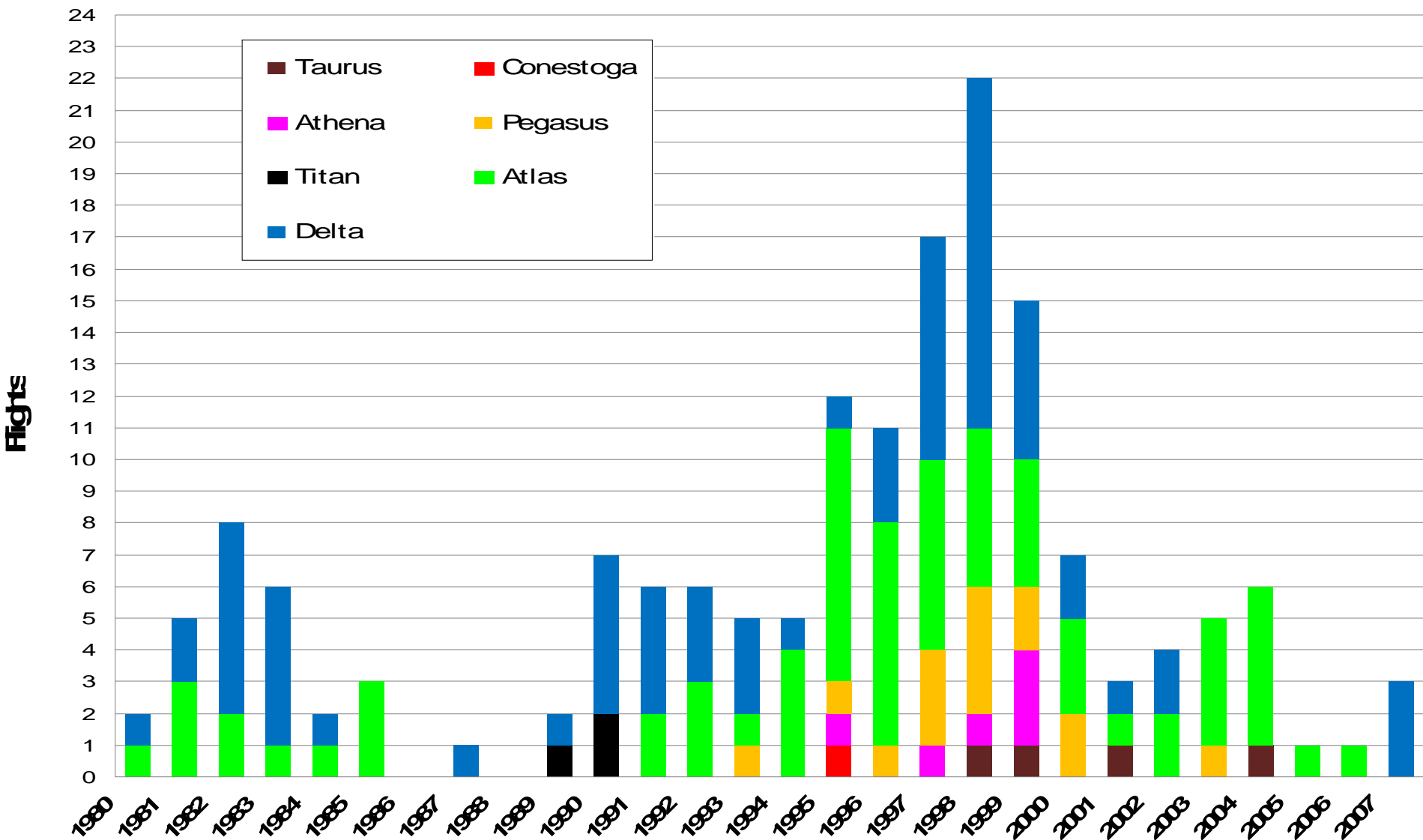
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- There are options in all vehicle classes (small, medium, heavy)
- The Delta II is shutting down, with re-start costs currently estimated at ~ \$100M
- There is an overcapacity of small and large (EELV)-class launch services
 - too many suppliers in those classes chasing too few customers and opportunities
 - not so clear in the medium-class without Delta II
- Piggy-backing is an option with larger launch vehicles. However, opportunities for co-manifesting may be limited and may introduce added risk.

U.S. Commercial Expendable Launch History

1980 - 2007

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NASA Launch Manifest

as of April 4, 2008

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FPB Approved 2/01/08 Release 4/04/08	2008				2009				2010				2011				2012				2013				2014				2015			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Small Class (SC) Pegasus (P) Taurus (T)																																
Medium Class (MC) Delta 732X Series (D3) Delta 742X Series (D4) Delta 792X Series (D) Delta 792X H (DH)																																
Intermediate (IC) / Heavy Class (HC) Atlas V (AV) Delta IV (DIV) Delta IV Heavy (IVH)																																
COTS NOTE: COTS Demo launch dates shown for informational purposes only - LSP does not control these dates.																																
Vehicle Unassigned																																

For NASA Planning Purposes Only

UR = UNDER REVIEW

△ = SCIENCE

□ = SPACE OPERATIONS

V = VAFB LAUNCH

A = ATP'd F = FIRM

○ = EXPLORATION SYSTEMS

◇ = DOD REIMBURSABLE

K = KWAJALEIN

U.S. Commercial Expendable Launch Vehicle Forecast

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- Administrator has requested a cohesive strategy on the launch question by the end of the summer. The Committee will review that strategy and brief the Council at future meetings.

Commercial Orbital Transportation System

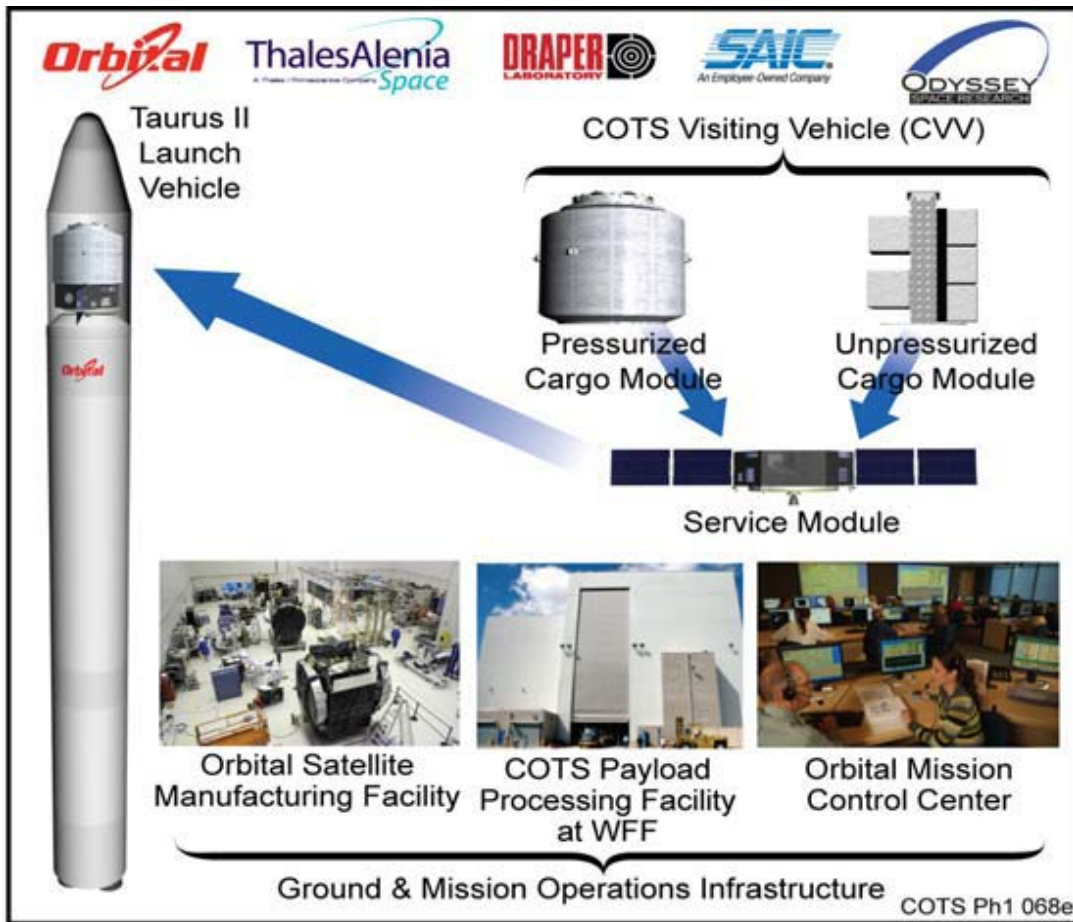
SpaceX and Orbital Sciences Corporation (OSC)

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- SpaceX has completed consolidating design and production under one roof
- The Space Act Agreement has been modified to reflect SpaceX's new testing and production schedule
- SpaceX still plans the Demo 3 flight to ISS to take place prior to Shuttle retirement
- OSC was recently selected as a second participant in COTS Phase I (development phase)
 - in October, the NAC recommended that NASA maintain at least two COTS participants through Phase I demonstration for ISS cargo delivery

COTS Phase I – Orbital Sciences Corporation

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Description & Features:

- Taurus II Launch Vehicle – derivative of Taurus I with Aerojet AJ-26 engines (2) & Castor 30 2nd stage
- Standard Service Module used for all missions – derived from STAR & Dawn spacecrafts
- Pressurized Cargo Module – Heritage: MPLM
- Unpressurized Cargo Module – Heritage: ExPRESS Logistics Carrier

Subs/Suppliers:

*Major Subs

- Thales-Alenia *
- SAIC *
- Draper*
- Odyssey*
- ATK
- Aerojet
- Yuzhnoye Design Office

COTS Phase I - SpaceX

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Description:

- Falcon 9 Launch Vehicle
- Dragon Crew/Cargo Spacecraft
- Falcon 9 can lift about 9 mT to ISS orbit and carry about 3 mT of actual cargo

Proposed Features:

- Flexible crew and cargo configurations
- Recoverable launch vehicle and spacecraft
- ISS cargo delivery & return demonstration planned for completion by March 2010
- **NASA Investment:**
 - Cargo Demonstration – up to \$278 M
 - Not funded Crew Option – up to \$308 M additional



<http://www.spacex.com/>



Commercial Orbital Transportation System

Conclusions

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- **COTS may be a player in medium launch, but is yet an unproven capability for science missions**
- **There are a number of options in the medium launch category. But the primary motivation with COTS is to:**
 - provide a transportation system to ISS in the time gap between Shuttle and Constellation
 - to use the commercial sector and competition to help lower costs
- **COTS's biggest benefit in the short term is in delivering pressurized and unpressurized cargo to ISS**
 - cargo return and crew transportation may provide opportunities in the longer-term
- **There is still uncertainty whether COTS can achieve its goals .**
Nevertheless, COTS cargo delivery is critical for maintaining ISS beyond 2010
 - SpaceX milestones have already slipped
- **Members of the Space Operations Committee will attend upcoming major design reviews**

Iran, North Korea, Syria Non-Proliferation Act (INKSNA)

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- NASA has an exemption to INKSNA (formerly ISNA, formerly INA) to purchase Russian crew (*Soyuz* seats) and cargo (*Progress* upmass) through December 31, 2011
- NASA is not pursuing an extension to the INKSNA exemption to buy Russian cargo services after 2011 for ISS, only crew transportation and rescue services
- Exemption language has been submitted to Congress (foreign relations and NASA authorization committees in both houses)

Pressurized Lunar Rover and Lunar EVA Capabilities

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- Participated with Exploration Committee
- A great deal of innovative thinking, potentially an enabler of early and extensive lunar operations. More reviews necessary, but a potential game-changer
- Concur with the Exploration Committee that it is important that the U.S. maintain this kind of capability

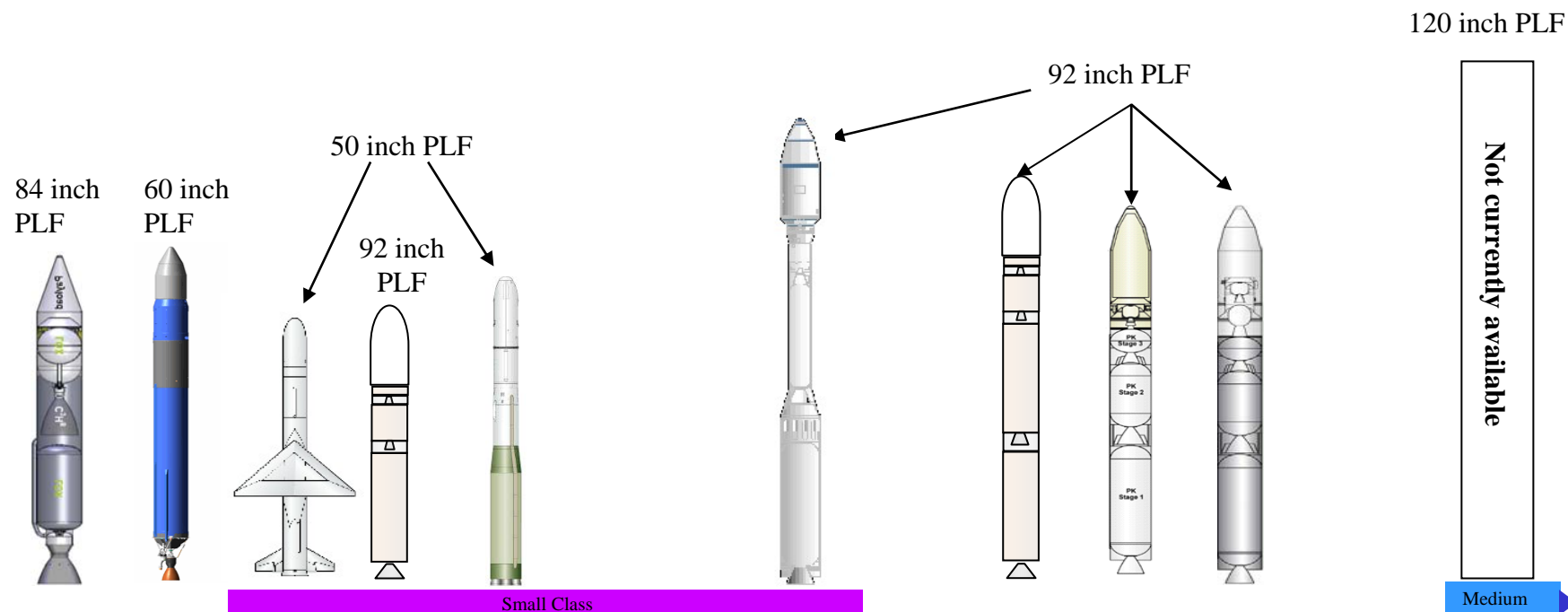
- Review NASA's expendable launch vehicle strategy (with Science Committee)
- Invited to attend major design reviews for COTS participants
- Review NASA Space Flight Human System Standards (SFHSS) and Human Integration Design Handbook (HIDH) (with Biomedical Subcommittee)
- Follow-up briefings from the ESMD Advanced Capabilities Division regarding linkages with the developing Lunar Science Institute (with Exploration Committee and Biomedical Subcommittee)
- Follow up briefing from NASA Human Research Program and other subject experts regarding hazards, risks and exposure limits for lunar habitation. (with Exploration Committee and Biomedical Subcommittee)
- Continue to monitor utilization of ISS as a National Laboratory (with Exploration Committee and Biomedical Subcommittee)
- Continue to monitor the development of the lunar outpost architecture for indefinite operational life (with Exploration Committee and Biomedical Subcommittee)
 - radiation exposure limits for long-duration surface stays, including utilization of ISS to accumulate data (with the Biomedical Subcommittee)
 - comparison with ISS hardware maintenance and logistical sustainability

BACKUP

U.S. Expendable Launch Vehicles

Small Class

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Vehicle	Quick-Reach	Falcon 1	Pegasus XL	Athena I	Minotaur I	SIGNIFICANT GAP	Taurus XL	GAP	Athena II	Minotaur IV	Minotaur V	GAP	Delta 7320
Orbit													
600 km 90 deg	TBD	200	250	~300	375		900		~1150	~1200	NA		1650
675 km Sun sync			225		325		750-800			1100	NA		1550
C3=0	NA	NA	NA	NA	NA		425		430 (b)	NA	400		7425=750
Perf risk	High	Med	Low	Med	Low		TBR Low		Med	Low	Low		(b) Low

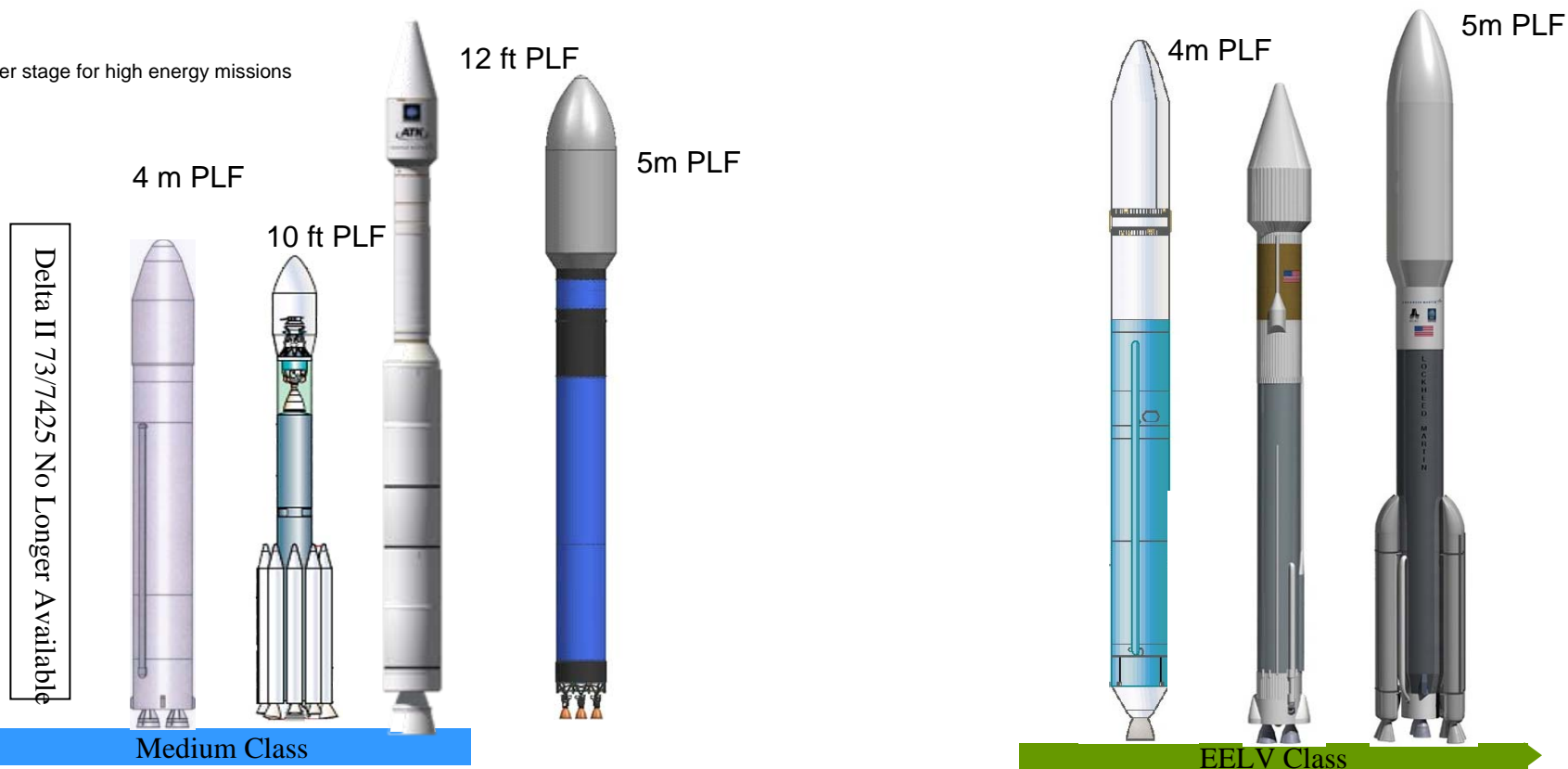
(b): Requires additional stage for high energy missions

U.S. Expendable Launch Vehicles

Medium and EELV Classes

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(a) Requires upper stage for high energy missions



Vehicle Orbit	Delta II 7320/5	Taurus 2	Delta II 7920/5	Athena IIIA	Falcon 9	SIGNIFICANT GAP	Delta 4040	Atlas V 401	Atlas V 551
C3=0	750 (a)	1250 (a)	1400 (a)	1850	2000		2750	3450	6300
C3=10	650 (a)	1050 (a)	1200 (a)	1350	1350		2100	2850	5300
675 km sun sync	1550	3600/2100	3200	3500 to 800km	TBS		6800	7250	13600
GTO	N/A	TBS	TBS	TBS	Not published		3985	4765	8570
Perf risk	Low	High	Low	High	High		Low	Low	Low